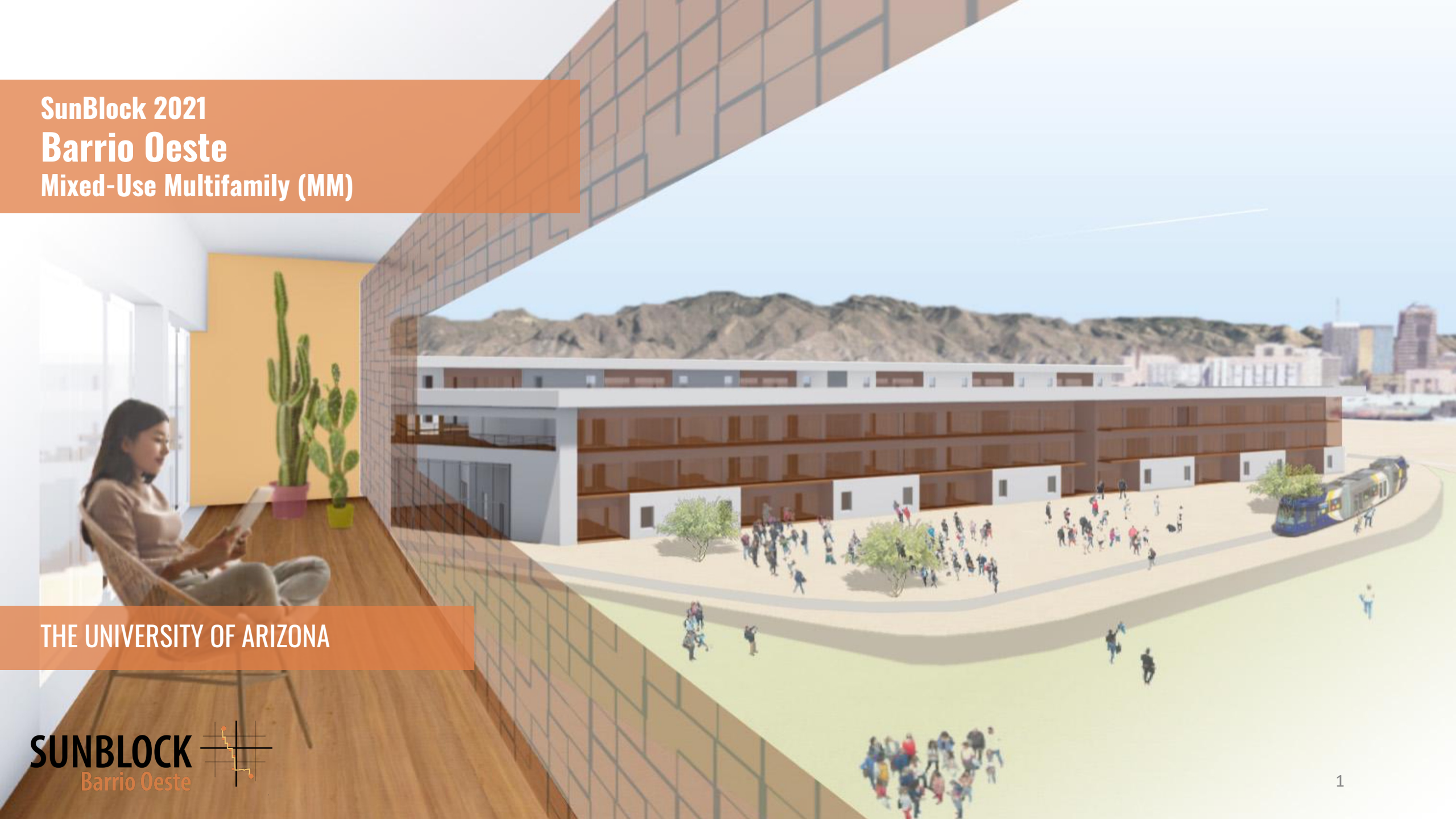
SunBlock 2021
Barrio Oeste
Mixed-Use Multifamily (MM)



THE UNIVERSITY OF ARIZONA

SUNBLOCK
Barrio Oeste

Our Team

SUNBLOCK
Barrio Oeste

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Goals + Constraints

More details on pages 4-7 in Design Narrative

SUNBLOCK
Barrio Oeste

Site Characteristics

- zone R-2, refers to Urban Residence, which provides for **urban, medium density**, single-family and **multifamily, residential development**
- zone I-1, describes a Light Industrial use, which refers to industrial uses that do not have offensive characteristics
- a special overlay zone called the **Downtown Area Infill Incentive District (IID)** which allows us to **exceed R-2 density limits** in the spirit of creating urban neighborhoods

Community Goals

- **Provide energy as crucial component of SunBlock**: a network that generates carbon-neutral thermal energy and stores it near where it will be used
- **Fill in the "missing middle" by building medium density** between the downtown area and the adjacent low density Barrio Sin Nombre, or the "Forgotten Neighborhood"
- **Establish and nurture relationships with community partners** that advocate for needs of community members and residents of Menlo Park

Design Goals

- sensitivity to the local climate, the history of Tucson, and the existing culture
- Higher density, lower costs: economy of scale
- Form follows function; user-centric design
- Consider biophilic principles for daylight, views, fresh air ventilation
- Collect, conserve and reuse energy through SunBlock
- Test building performance with climate data representing Tucson in the future
- Use local labor and materials

City of Tucson

living streets alliance

Menlo Park, Tucson's Birthplace

Pima County Community Land Trust

Tucson, Arizona, USA

Hot - Dry Climate | ASHRAE Climate Zone 2B

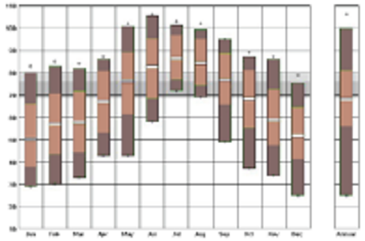


Figure 6.10 Monthly Temperature

- Large daily temperature swings
- Annual average high of 106°F
- Annual average low of 25°F

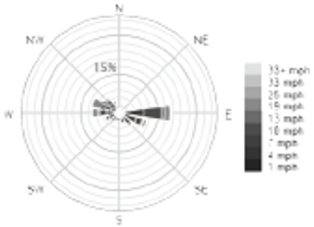


Figure 6.11 Annual Wind Rose

- Minimal wind speeds year round
- Primary winds come from the East
- Difficult to cross ventilate

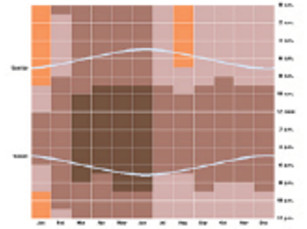


Figure 6.12 Monthly Relative Humidity

- Jan and Aug are monsoon season
- Low relative humidity most of year
- Less than 20% in early summer

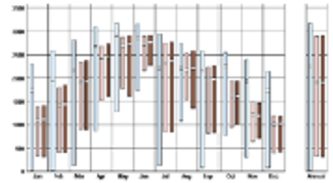


Figure 6.13 Daily Radiation

- High levels of radiation year round
- Most direct radiation in May
- Least direct radiation in winter months

The built environment accounts for nearly 40% of global carbon emissions. -Carbon Leadership Forum

SunBlock Barrio Oeste reduces emissions while providing well-designed, livable spaces.

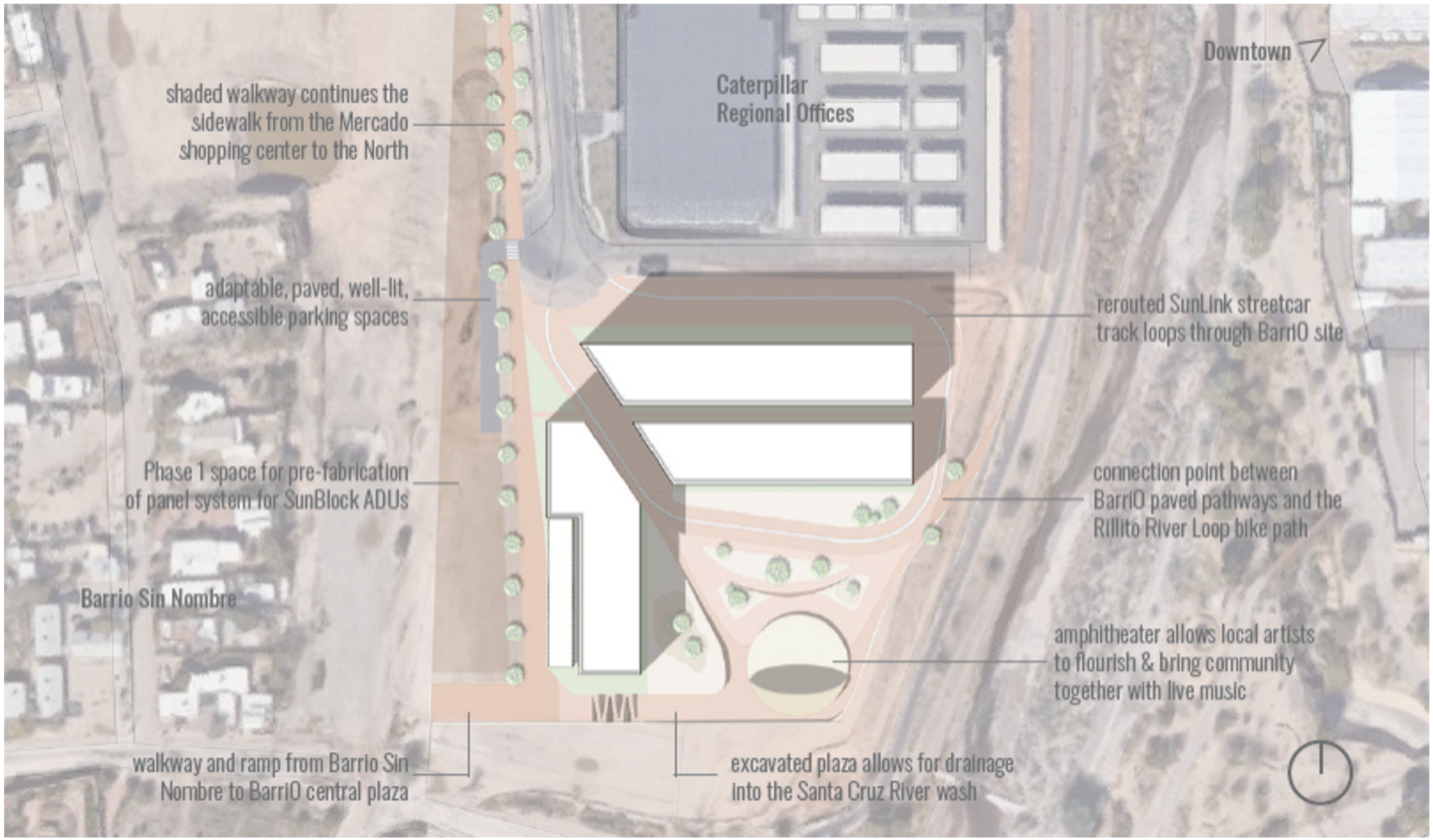
Architecture

More details on pages 8-11 in Design Narrative

SUNBLOCK
Barrio Oeste

Project Goals

- engage with overlooked Barrio Sin Nombre neighborhood to the West without invading by providing a route to plaza
- use building form to invite foot traffic generated from the Mercado shopping center to the North
- emphasize urban feel and increase responsible travel by rerouting the Sunlink streetcar through the site
- celebrate the iconic Sentinel Peak and Santa Catalina mountain range by preserving NE and SW views
- bring the community together in the heart of Barrio Oeste, the central plaza



Architecture

BarriO is a mixed use multi-family development of three buildings;
in total, 18.4% is mixed use and 82.6% is residential.

More details on pages 8-11 in Design Narrative

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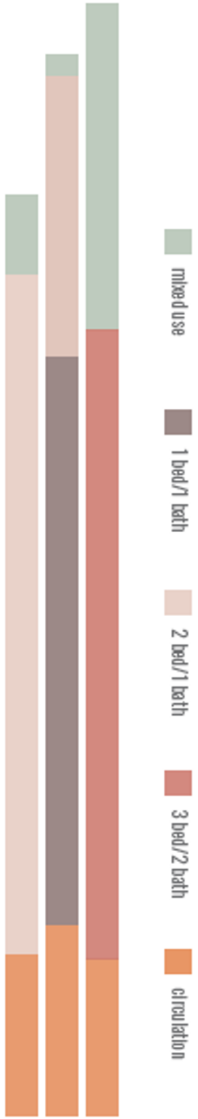
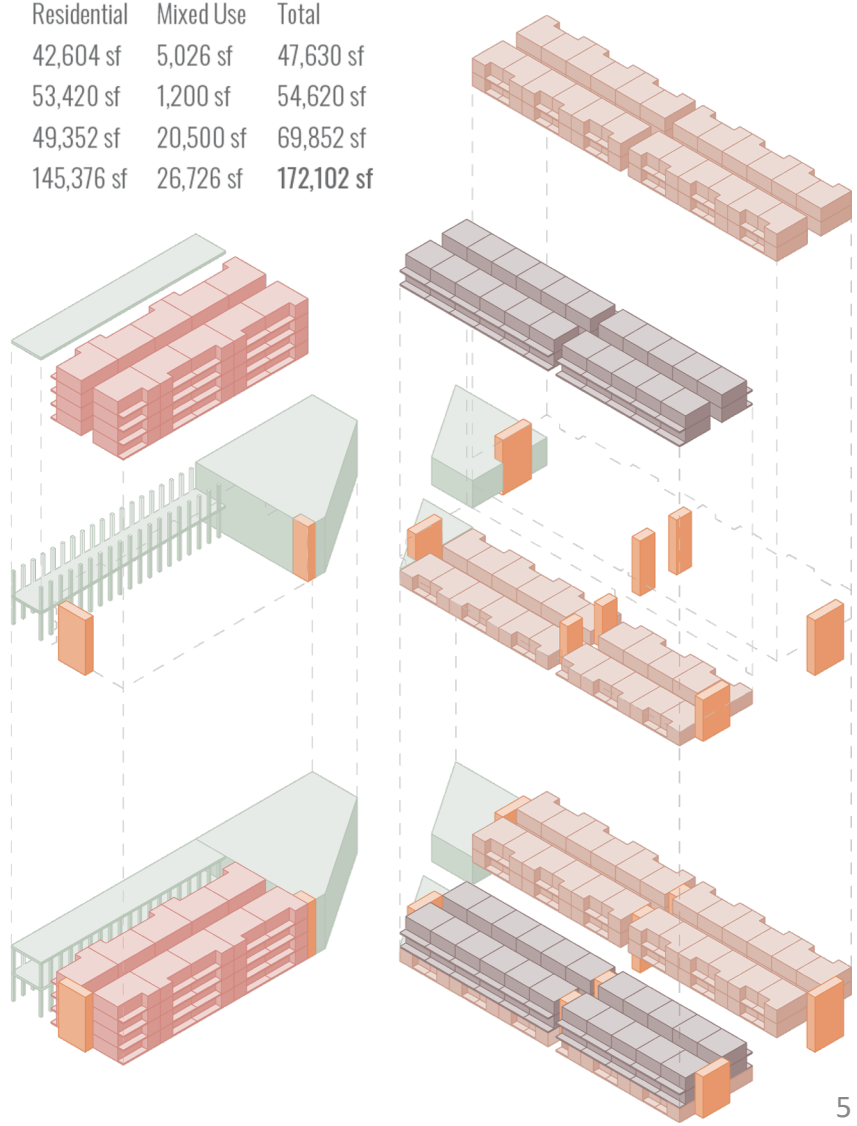
Barrio Oeste

Building Program



	Residential	Mixed Use	Total
Building 1	42,604 sf	5,026 sf	47,630 sf
Building 2	53,420 sf	1,200 sf	54,620 sf
Building 3	49,352 sf	20,500 sf	69,852 sf
Total	145,376 sf	26,726 sf	**172,102 sf**



Market Analysis

More details on pages 15-17 in Design Narrative

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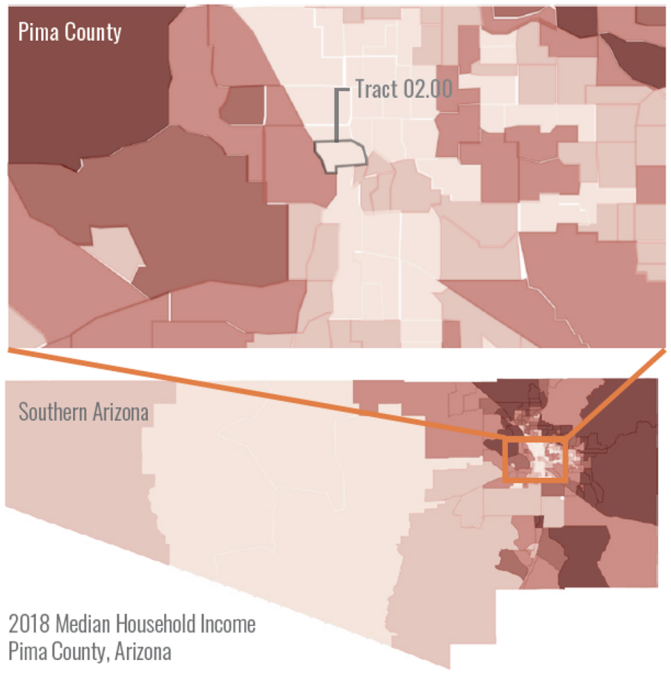
Barrio Oeste

Menlo Park Target Market

According to the 2018 Census Bureau and ACS 5-yr Estimate, **Menlo Park has one of the lowest median household incomes compared to other neighborhoods in Pima County.** The map below shows all tracts in Pima County, AZ keyed by their Median Household Income. The map on the right outlines census tract 2.00, where the majority of Menlo Park is.



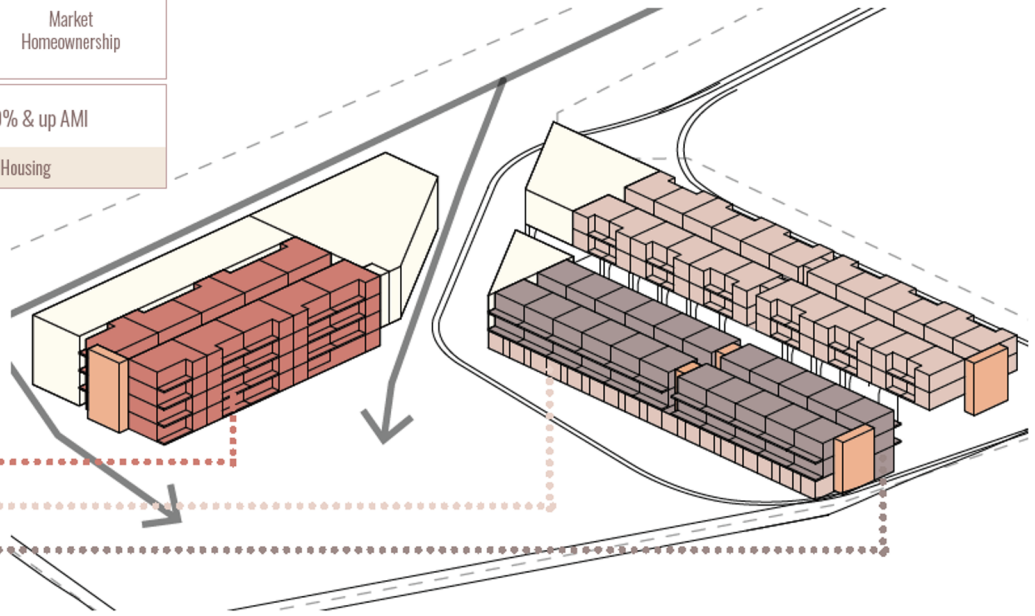
Housing Spectrum

4 Affordable Rental Housing	5 Affordable Homeownership	6 Attainable/Workforce Housing	7 Market Rental Housing	8 Market Homeownership
0% - 80% AMI	45% - 100% AMI	60% - 120% AMI	100% - 120% & up AMI	
Non-market Housing			Market Housing	

Tucson BarriO

average rent:	$720 - $1200
affordable rent:	$600 - $1500
market rate rent:	$800 - $2000

Unit Type	# Affordable	# Market Rate
3 bed/2 bath	20 units	20 units
2 bed/1 bath	30 units	30 units
1 bed/1 bath	22 units	22 units
	72 units	72 units



Young Professionals
Affordable single units target older college students and emerging graduates looking to get on their feet as they enter the workforce.

Single Parents
Menlo Park is among neighborhoods in the city with the highest population of single parents. Affordable places to live on a single-salary household are needed.

Multi-Generational Families
Barrio Sin Nombre is a leading example of local houses staying within the resident's family for several generations; BarriO provides opportunities for new generations to live close to the family home, while cultivating connections to new residents.

Durability and Resilience

More details on pages 18-19 in Design Narrative

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Acknowledging the Future

Under a high carbon emissions scenario, Tucson's climate in 2080 will feel most like today's climate near Hermosillo, Mex. Today, the typical winter in Hermosillo, Mexico is 10.7°F (5.9°C) warmer and 38.5% drier than winter in Tucson.
BarriO exceeds the PHIUS+2021 Passive house Requirements in the year **2080.**

Embracing Uncertainty

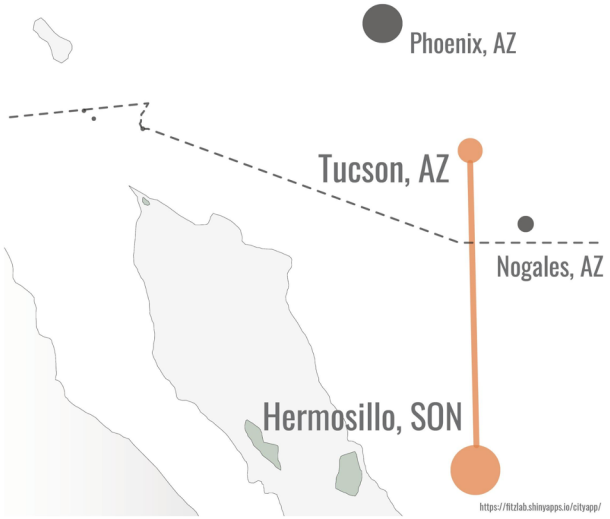
BarriO's ability to respond to natural and man-made disasters is based on material selection and flexibility of the mixed-use spaces. In case of an emergency (blackout, power outage, medical, etc.), the residents have easy accessibility to exit the buildings. The community app promotes communication in case of any and all emergencies.

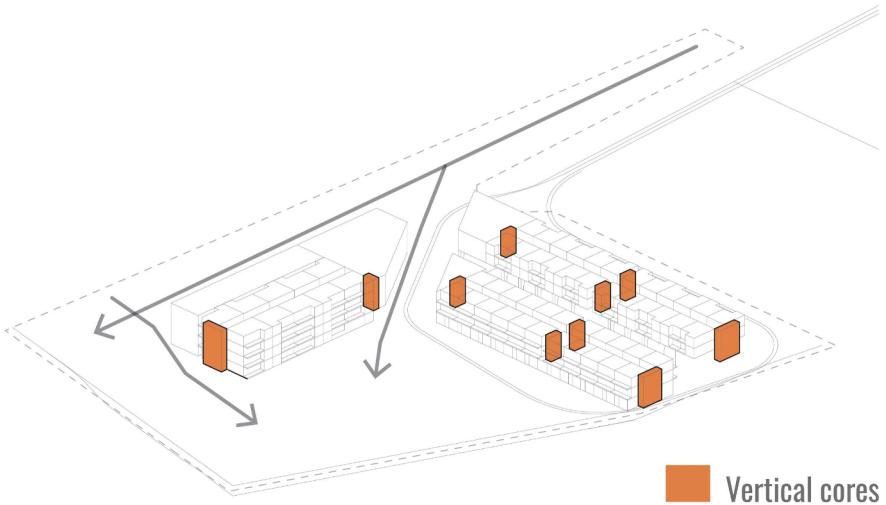
Unexpected Events

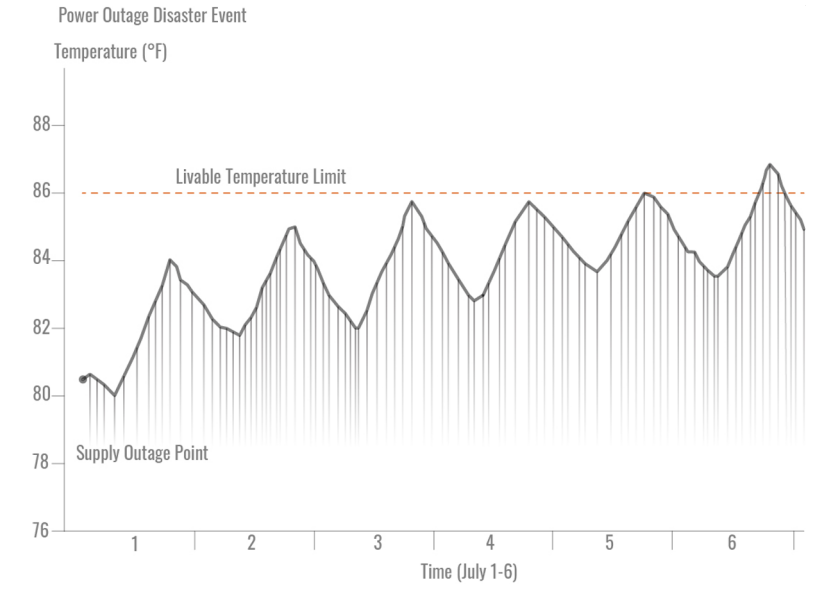
Climate change exposes the vulnerability of the power grid. This graph shows BarriO's passive survivability during the hottest week of the year in Tucson.

Dynamic Model Results

	PHIUS 2021	B1	B2	B3	Average
Heating Demand	1.2	0.00	0.00	0.00	**0.00** kBTU/ sf yr
Cooling Demand	13.4	15.91	11.58	9.26	**12.25** kBTU/ sf yr
Heating Load	1.8	0.24	0.00	0.00	**0.08** BTU/ sf hr
Cooling Load	4.4	3.4	2.0	2.12	**2.51** BTU/ sf hr
Source Energy	4411	1925.63	1547.25	652.72	1375.2 kWh/ Person yr







Durability and Resilience

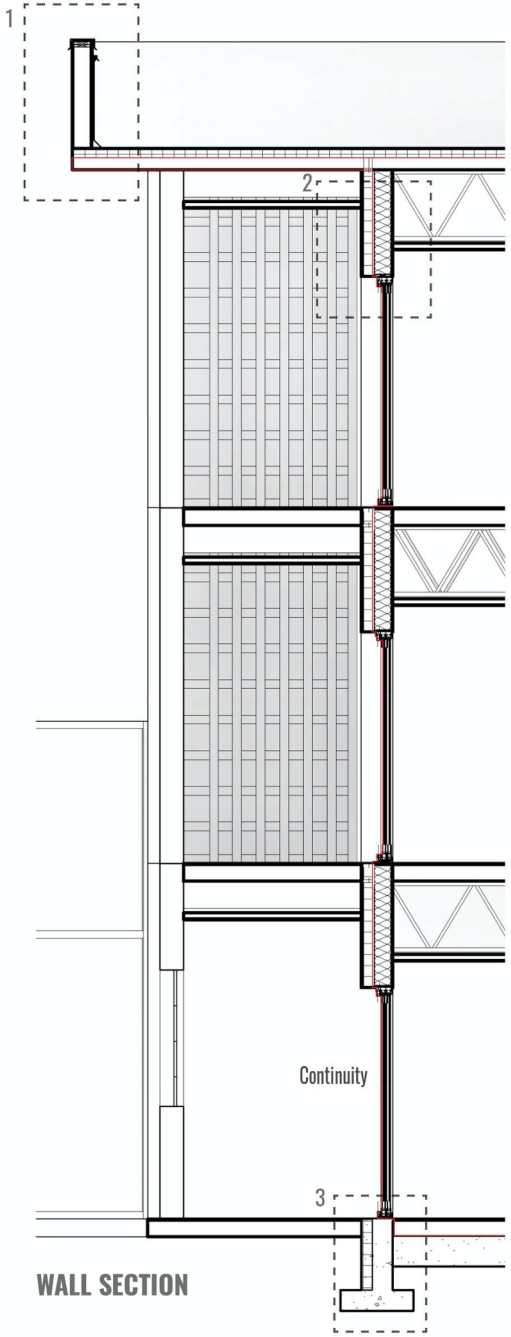
Building Enclosure Integration

Given the hot/arid climate in the Sonoran desert, Tucson, Arizona is characterized by low annual rainfall. However, since 2008 the National Weather Service has identified Tucson's official monsoon season as starting June 15 and ending September 30. The storms bring much needed moisture to the desert, but are followed by lightning, high winds, flash flooding, hail and driving conditions that can be dangerous. BarriO's building enclosure is consciously integrated to prevent unexpected conditions like termite infests, cracking, and fissuring (dimensional changes in materials).

Rain Control
This layer controls the passage of liquid water after long exposure to moisture. Therefore, it is the most external material, in this case, stucco using lime plaster.

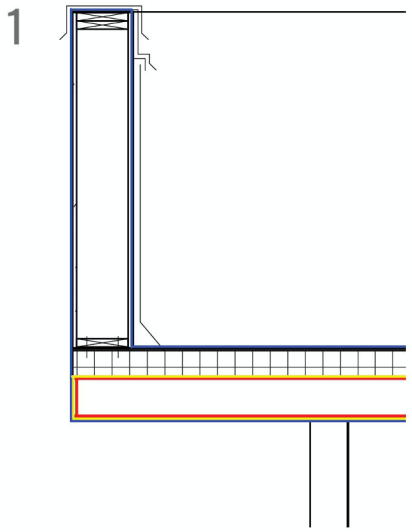
Air/Vapor Control
Use of vapor retarder to impede moisture flow (continuous)

Thermal Control
This layer controls the transfer of heat. The use of wood fiber insulation (R-value/in: 3.8) as the thermal control layer ensures the building's life cycle due to its highly durable properties.

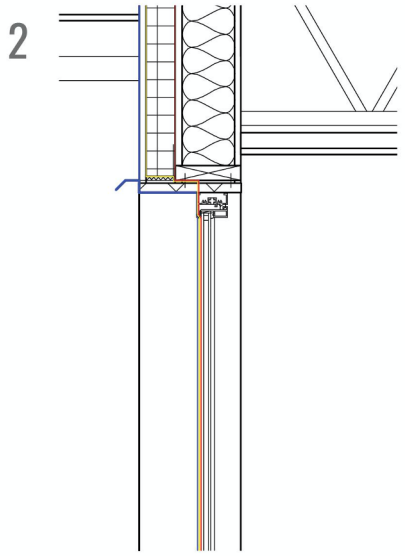


WALL SECTION

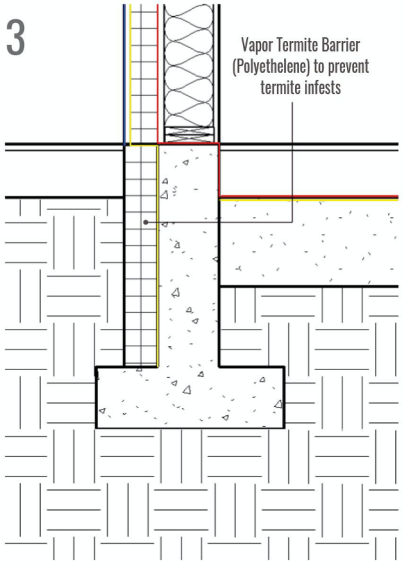
More details on pages 18-19 in Design Narrative



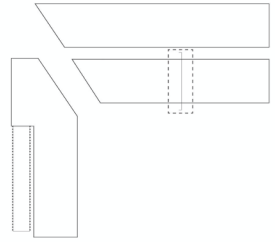
ROOF DETAIL



WINDOW DETAIL



FOUNDATION DETAIL



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Embodied Environmental Impact

More details on pages 20-21 in Design Narrative

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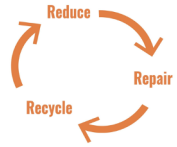
Barrio Oeste



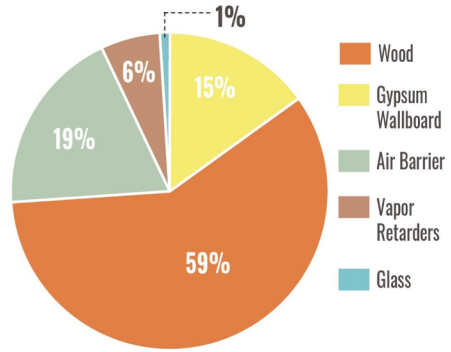
Our Priorities

Intended Service Life: 80 years
We ambition both the mixed use space, as well as the housing component of the project to be focused on the users' comfort, and to promote and improve physical and mental health. Our main question is: **How can we make this possible without subjecting the planet with further harm?**

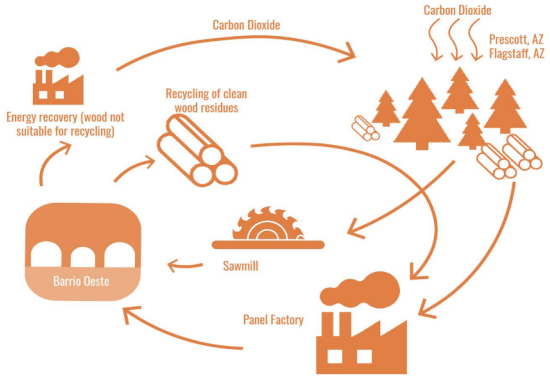
Wood Vs. Concrete

How do we know we made the right decisions? Based on an analysis through OneClick LCA, our team was able to compare the impact of BarriO's material selection and a concrete building at the same scale. BarriO proposes a collaboration between the developer and the Forest Stewardship Council, to promote ethical and conservative wood harvesting techniques.

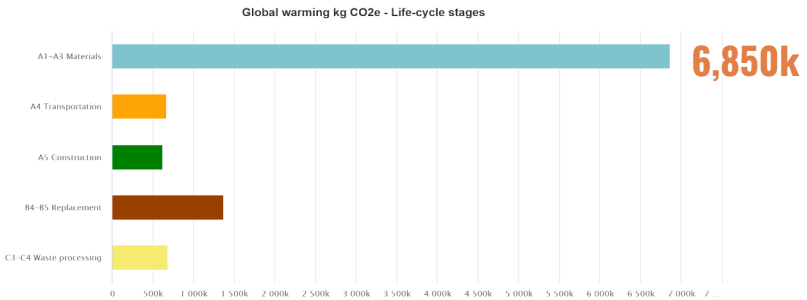
Around **59%** of BarriO's structure/ envelope is made of wood based products.



BarriO STRUCTURE/ ENVELOPE MATERIAL COMPOSITION

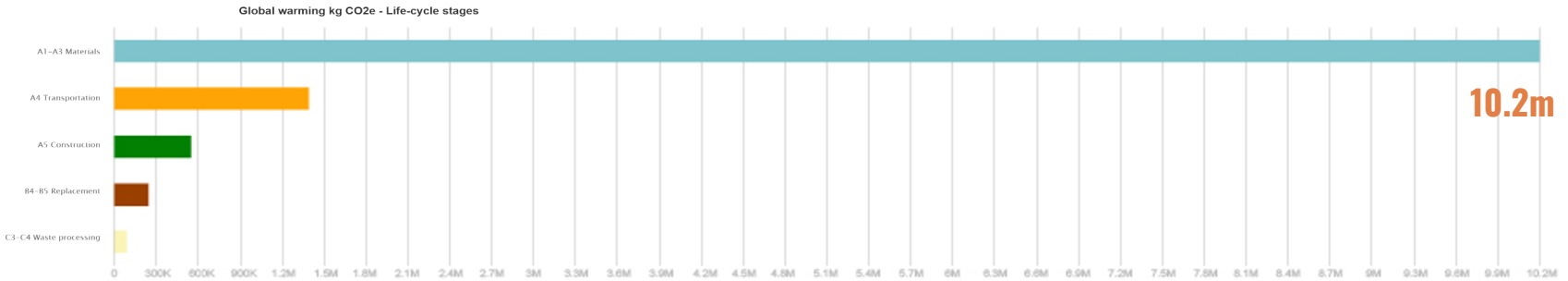


Beetle kill timber specifically in Flagstaff, Arizona, which is 257 miles away from Tucson, can be used towards building construction.



reclaimed wood used to fabricate screen wall in BarriO cafe

BARRIO Building Analysis- GLOBAL WARMING BY LIFE CYCLE STAGES



CONCRETE Building Analysis- GLOBAL WARMING BY LIFE CYCLE STAGES

Energy Performance

More details on pages 32-34 in Design Narrative

SUNBLOCK
Barrio Oeste

Energy Performance Values

Tucson AZ, USA- ASHRAE Climate Zone 2B (Hot, Arid)

140,072 ft2 conditioned space

TARGET EUI: 79 kBTU/sf yr
BarriO AVERAGE EUI: 19.36 kBTU/sf yr
The average EUI of a typical building in our climate is 50 kBTU/sf yr.

Source Energy (before PV): 3203 kWh/Person yr

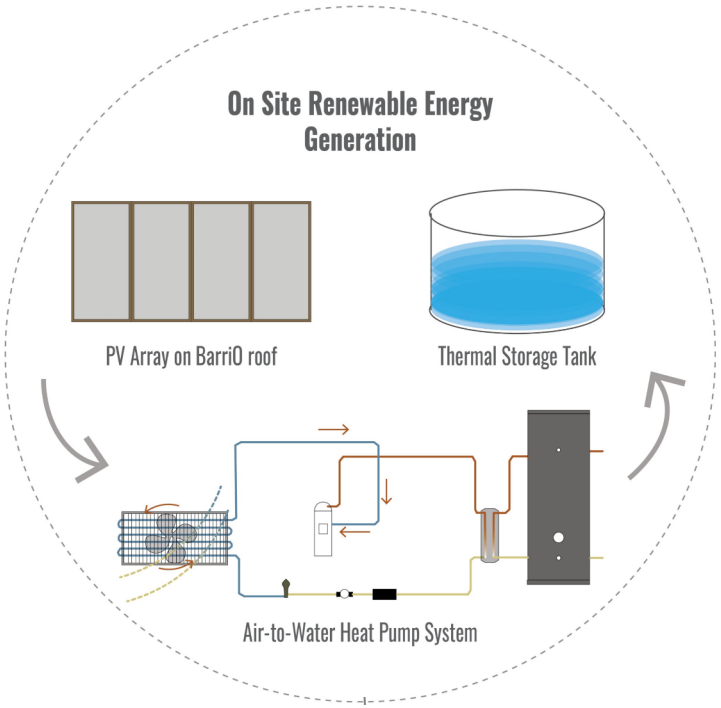
Total sf for PV array: 58,080 sf (3 buildings)

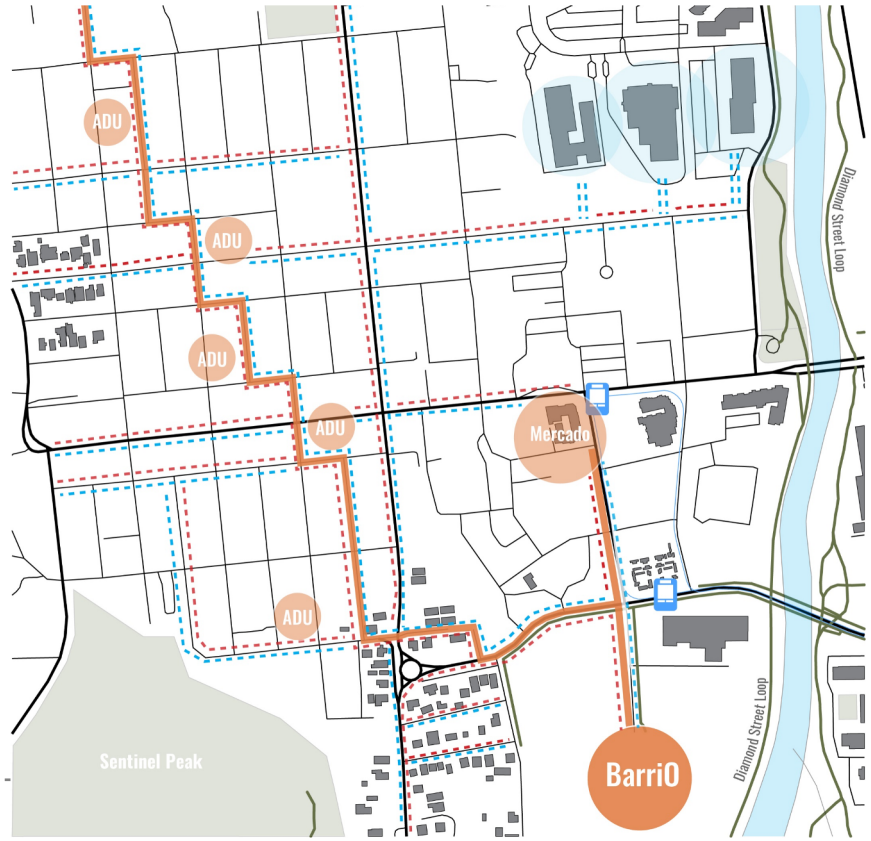
	Code	DOE ZERH	PHIUS	BarriO	PHIUS+2021	Targets	BarriO B1	BarriO B2	BarriO B3	
Wall	R-13	R-13	R-18	R-29.9						
Foundation	R-0	R-0	R-0	R-13.02	Heating Demand	1.2 kBtu/ft²yr	0.22	0.16	0.6	kBtu/ft²yr
Roof	R-38	R-38	R-40	R-48.8	Cooling Demand	13.4 kBtu/ft²yr	14.65	14.34	14.17	kBtu/ft²yr
Windows	U 0.4	U 0.4	U 0.25	U 0.22	Heating Load	1.8 Btu/hr ft²	2.55	2.5	1.85	Btu/hr ft²
		SHGC 0.25	SHGC 0.25	SHGC 0.25	Cooling Load	4.4 Btu/hr ft²	4.38	4.31	3.83	Btu/hr ft²
Airtightness	5 ACH	3 ACH	0.06 CFM/SF = 0.34 ACH50	0.28 ACH50	Source Energy	4411 kWh/Person yr	0	0	0	kWh/Person yr
					Site Energy	9.05 kBtu/ft²yr	-18.07	-0.78	-1.61	kBtu/ ft²yr

SunBlock

HOW IT WORKS?
A PV array on site collects solar energy during the day. This surplus energy is reserved in thermal storage tanks to be then heated or chilled throughout air-to-water heat pumps (convert electric to thermal energy). Heated and chilled water is transported throughout the neighborhood.

In collaboration with the ADU Solar Decathlon Project, the SunBlock system integrates a significant district energy sharing. BarriO highlights the ADU's at the north portion of the site.





Energy Performance

More details on pages 32-34 in Design Narrative

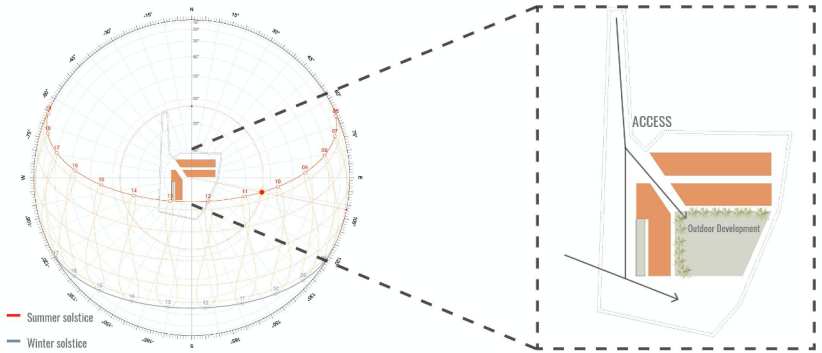
SUNBLOCK
Barrio Oeste

Sufficient Renewable Energy Generation

In order to ensure the project generates enough renewable energy, BarriO is part of the Sunblock district energy sharing. Due to high temperatures in Tucson, the use of solar energy benefits the buildings in the short and long term. BarriO provides enough roof area to arrange an adequate number of photovoltaic panels.

Orientation

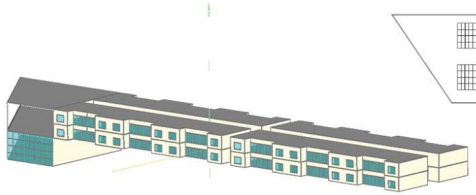
By considering Norbert Lechner's Three Tier Approach, our team implemented sustainable design strategies since Tier 1 of the design process.



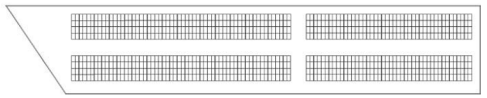
ORIENTATION ANALYSIS DIAGRAM

Building 1

Heating Demand	Heating Load	Site Energy
0.22 kBtu/ft²yr	2.55 kBtu/ft²	-18.07 kBtu/ft²yr
Cooling Demand	Cooling Load	Source Energy
14.65 kBtu/ft²yr	4.38 kBtu/ft²	0 kWh/Person yr



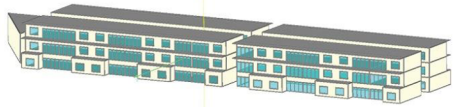
WUFI MODEL- BUILDING 1



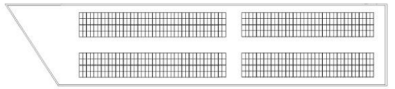
816 PV Panels

Building 2

Heating Demand	Heating Load	Site Energy
0.16 kBtu/ft²yr	2.5 kBtu/ft²	-0.78 kBtu/ft²yr
Cooling Demand	Cooling Load	Source Energy
14.34 kBtu/ft²yr	4.31 kBtu/ft²	0 kWh/Person yr



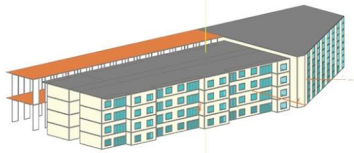
WUFI MODEL- BUILDING 2



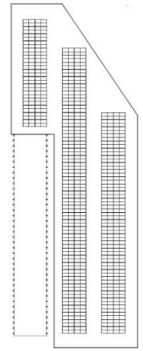
608 PV Panels

Building 3

Heating Demand	Heating Load	Site Energy
0.6 kBtu/ft²yr	1.85 kBtu/ft²	-1.61 kBtu/ft²yr
Cooling Demand	Cooling Load	Source Energy
14.17 kBtu/ft²yr	3.83 kBtu/ft²	0 kWh/Person yr



WUFI MODEL- BUILDING 3



688 PV Panels

Energy Performance

More details on pages 54-56 in Design Narrative

SUNBLOCK Barrio Oeste

Energy Model

BarriO energy performance is calculated through a WUFI model analysis. Due to the project's scale, each building is modeled separately to meet their own respective targets.

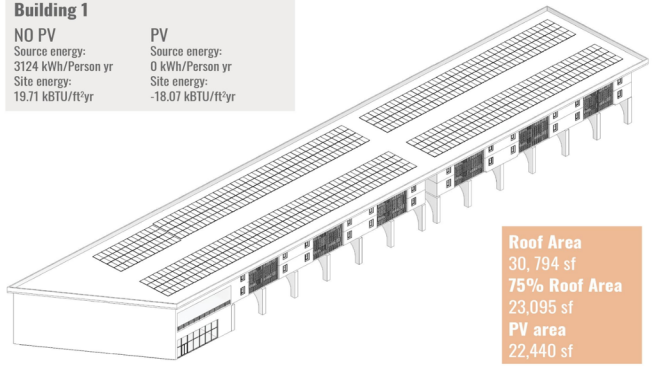
The Mixed-Use Multifamily Building Division is defined as a blend of residential and commercial building area.

BarriO Parameters:

- 144 Dwelling Units
- Tallest buildings, (1 and 3) have 4 stories
- Building Maximum Size Allowed: 288,000 sf
- Gross Floor Area: 172, 102 sf
- 18.4% is mixed use and 82.6% is residential (by floor area).
- The entire complex soars past the 79 source EUI target, since the average EUI is 19.36 kBTU/sf yr.

Building 1

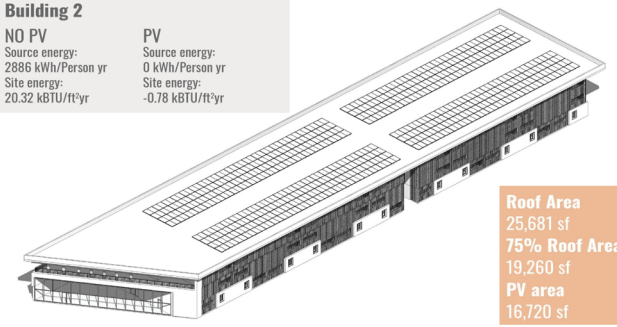
NO PV	PV
Source energy: 3124 kWh/Person yr	Source energy: 0 kWh/Person yr
Site energy: 19.71 kBTU/ft²yr	Site energy: -18.07 kBTU/ft²yr



Roof Area 30, 794 sf
75% Roof Area 23,095 sf
PV area 22,440 sf

Building 2

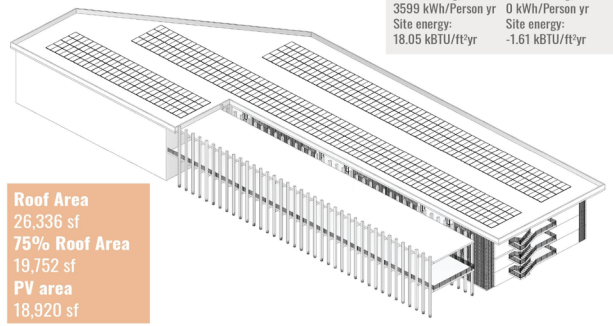
NO PV	PV
Source energy: 2886 kWh/Person yr	Source energy: 0 kWh/Person yr
Site energy: 20.32 kBTU/ft²yr	Site energy: -0.78 kBTU/ft²yr



Roof Area 25,681 sf
75% Roof Area 19,260 sf
PV area 16,720 sf

Building 3

NO PV	PV
Source energy: 3599 kWh/Person yr	Source energy: 0 kWh/Person yr
Site energy: 18.05 kBTU/ft²yr	Site energy: -1.61 kBTU/ft²yr



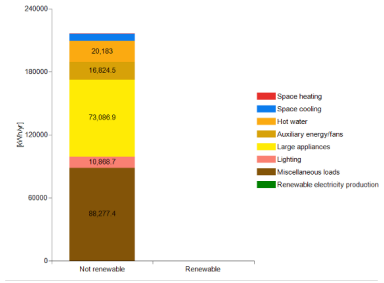
Roof Area 26,336 sf
75% Roof Area 19,752 sf
PV area 18,920 sf

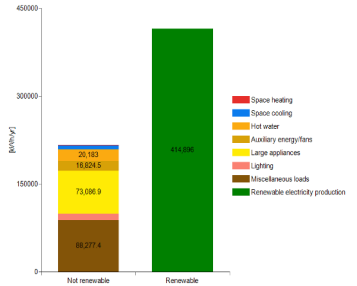
Potential On-Site Renewable Energy

	Building 1	Building 2	Building 2
Roof Area (sf)	30, 794 sf	25, 681 sf	26, 336sf
Roof Area (m^2)	2860.85 m^2	2385.84 m^2	2446.69 m^2
Area x 0.75 (75%)= y	2145.63 m^2	2126.8 m^2	1835.01 m^2
y x 0.16 (16%) Efficiency	343.3 kW	340.28 kW	293.6 kW
kW/ year	603, 320	603, 320	515, 977
Site energy (kBtu/ sf yr)	-35.24	-28.02	-11.28

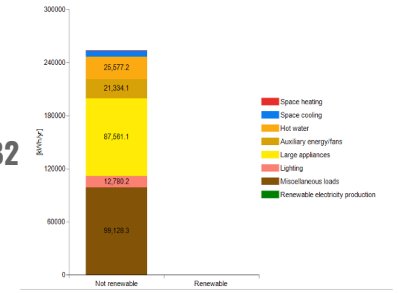
Before PV | **After PV**

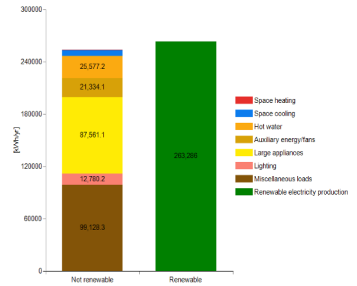
B1





B2





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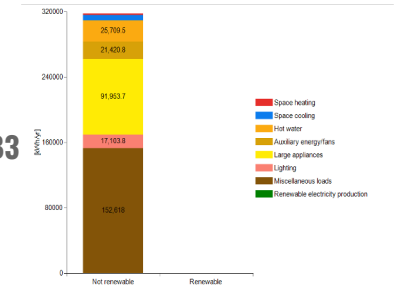
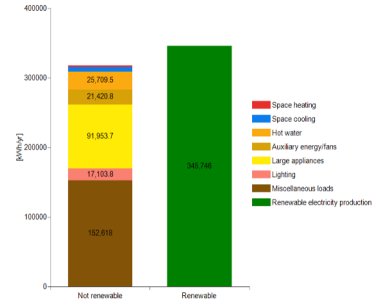




Energy Performance

More details on pages 54-56 in Design Narrative

SUNBLOCK
Barrio Oeste

Lighting, Plug Loads, HVAC System Values

Lighting Power Densities W/ ft2
Building 1
0.34 Watts/ sf
Building 2
0.31 Watts/ sf
Building 3
0.44 Watts/ sf

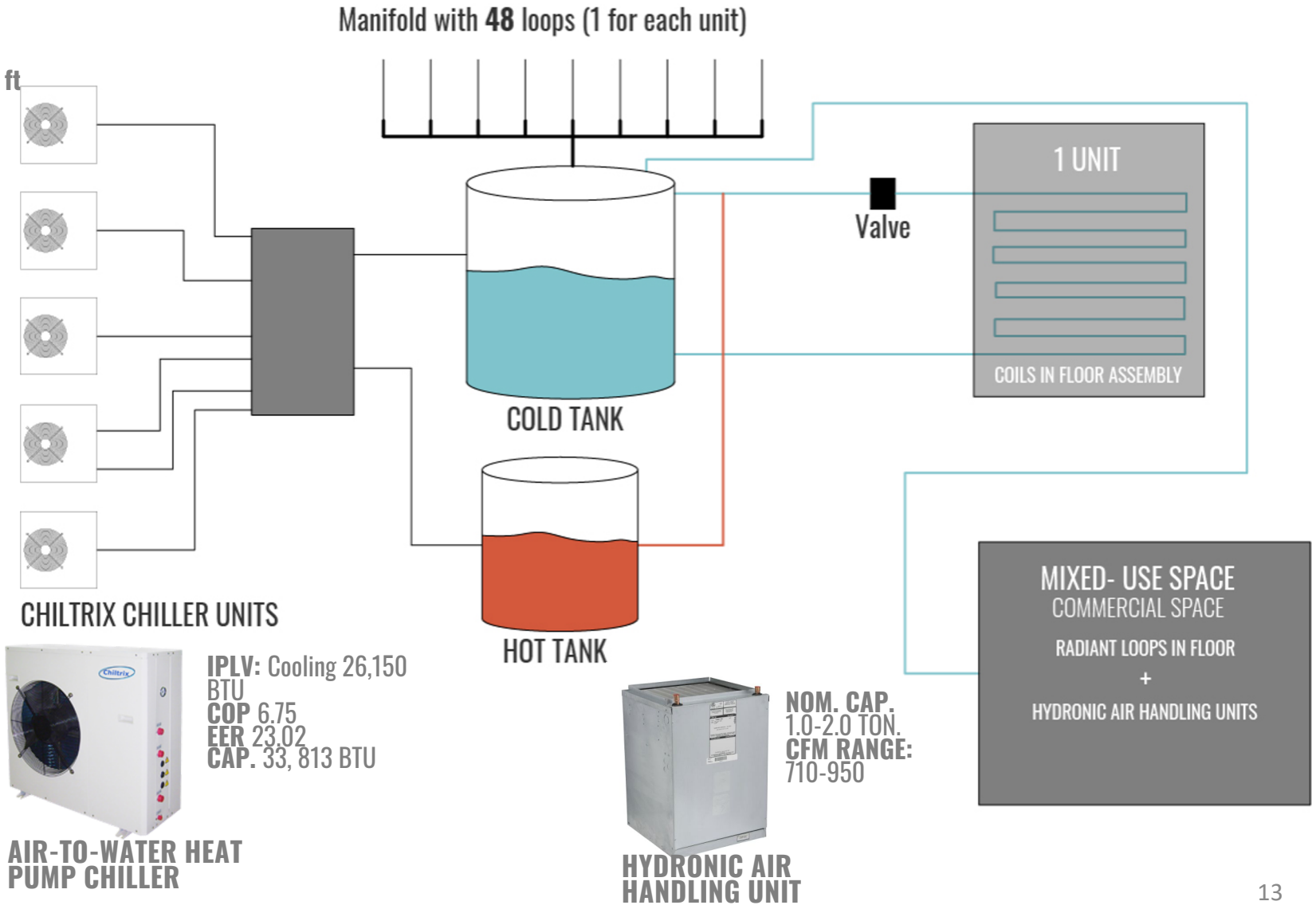
Plug Loads Densities W/ ft
Building 1
2.77 Watts/ sf
Building 2
2.43 Watts/ sf
Building 3
3.95 Watts/ sf

HVAC Sizing Capacities and Efficiencies

Supply per Bedroom (4" round duct):
One Bedroom: 30 cfm
Two Bedroom: 15 cfm
Three Bedroom: 20 cfm

Supply Living Room (6" round duct):
One Bedroom: 45 cfm
Two Bedroom: 30 cfm
Three Bedroom: 40 cfm

Exhaust Bathroom (4" round duct): 25 cfm
Exhaust Kitchen (6" round duct): 35 cfm
Intake and Exhaust: 8" round duct with 2" of insulation.



Engineering

More details on pages 12-14 in Design Narrative

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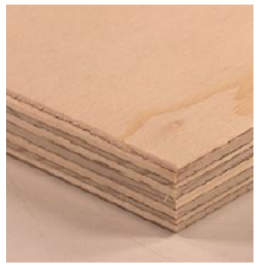
Barrio Oeste

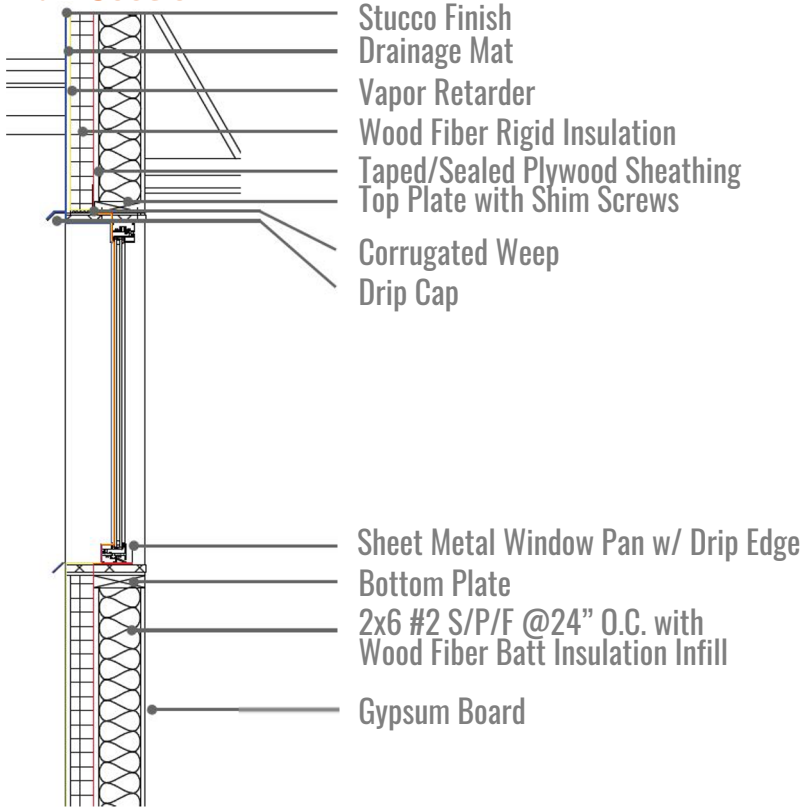
Primary Materials





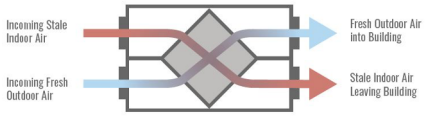



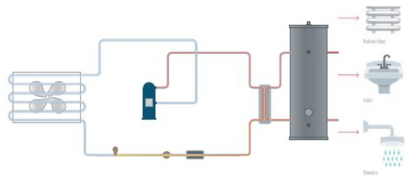

Wall Section

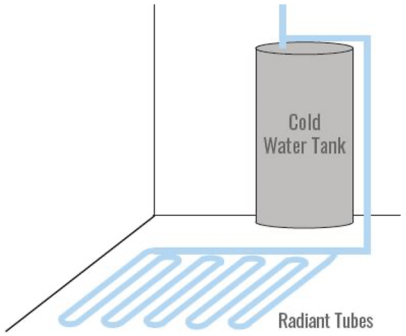


HVAC Systems

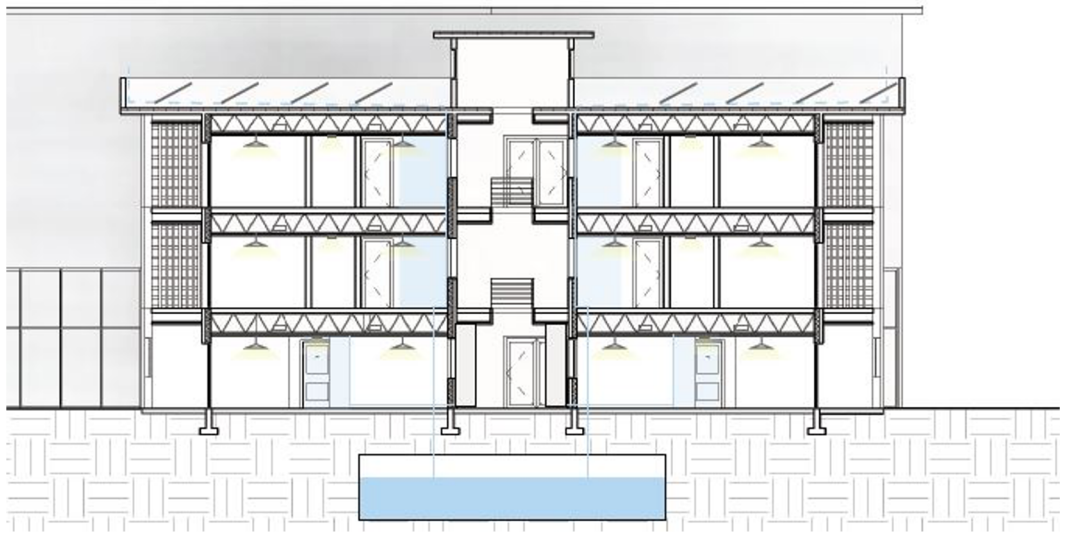
Energy Recovery Ventilator (ERV)
Dedicated Outdoor Air System (DOAS)
Radiant Floor with Air to Water Heat Pump







Barrio Oeste can collect 256,980 gallons of rainwater per year!

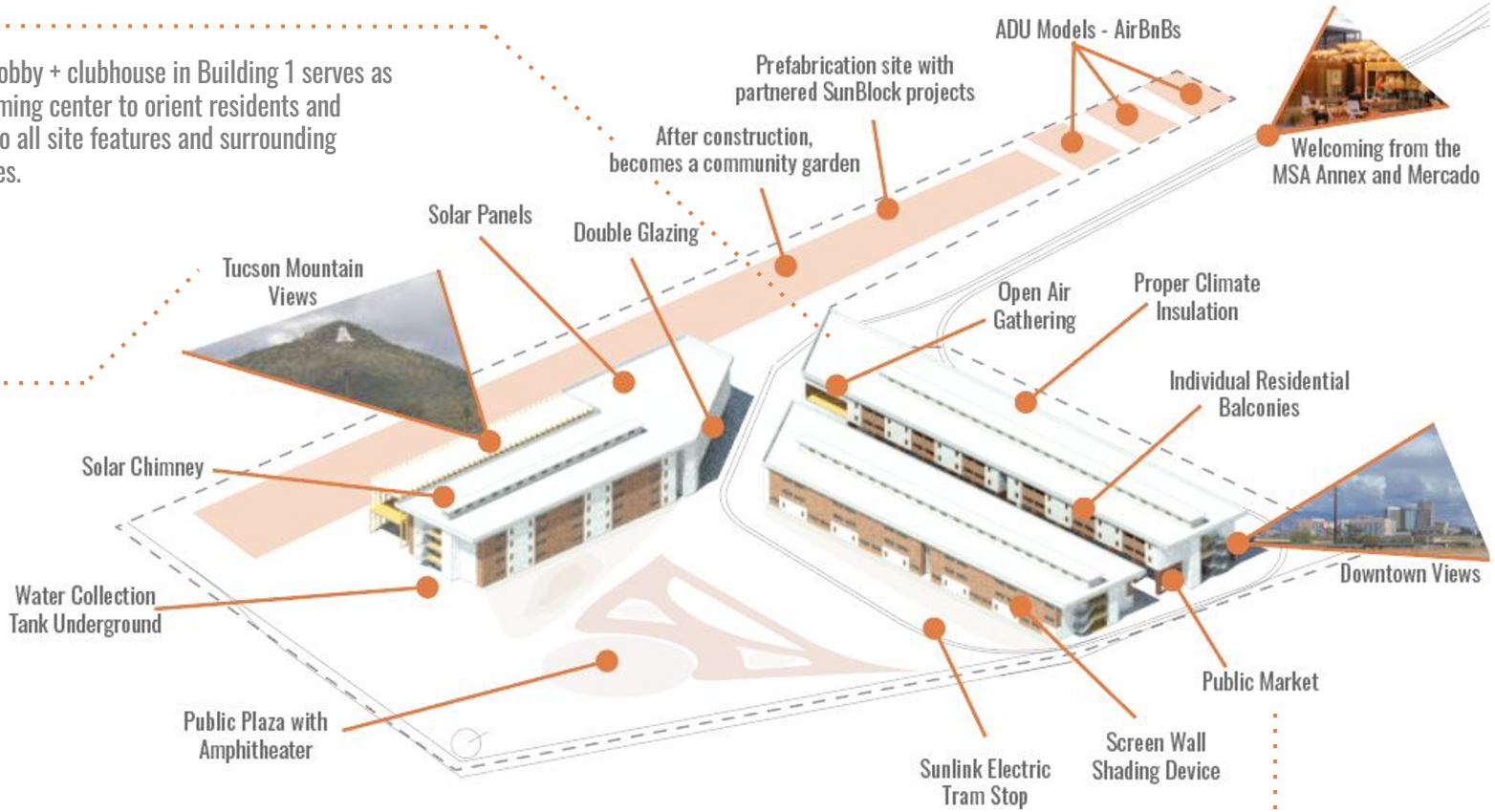


Integrated Performance

More details on pages 22-25 in Design Narrative

SUNBLOCK
Barrio Oeste

BarriO lobby + clubhouse in Building 1 serves as a welcoming center to orient residents and guests to all site features and surrounding amenities.



Site Features

BarriO is a distinctive site with many well-loved Tucson features in proximity, including the Tucson Mountain range with hiking trails, the Diamond Loop biking trail, downtown Tucson, the Mission Garden, and the Mercado shopping center. The electric streetcar (Sunlink) runs within the project to promote a more sustainable option for travel.

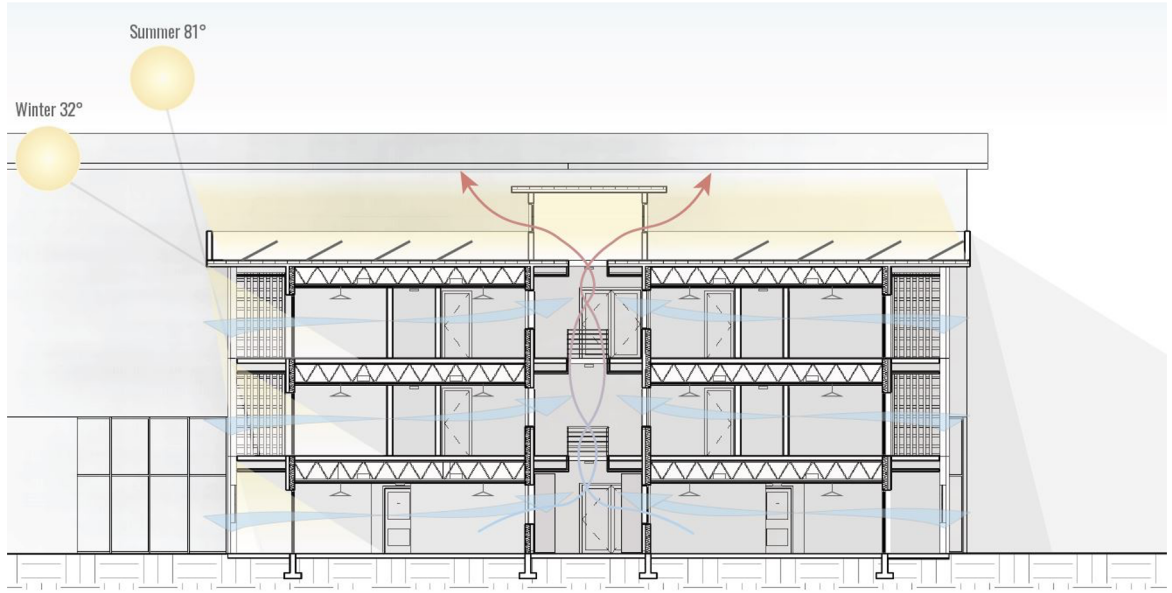
Integrated Performance

More details on pages 22-25 in Design Narrative

SUNBLOCK
Barrio Oeste

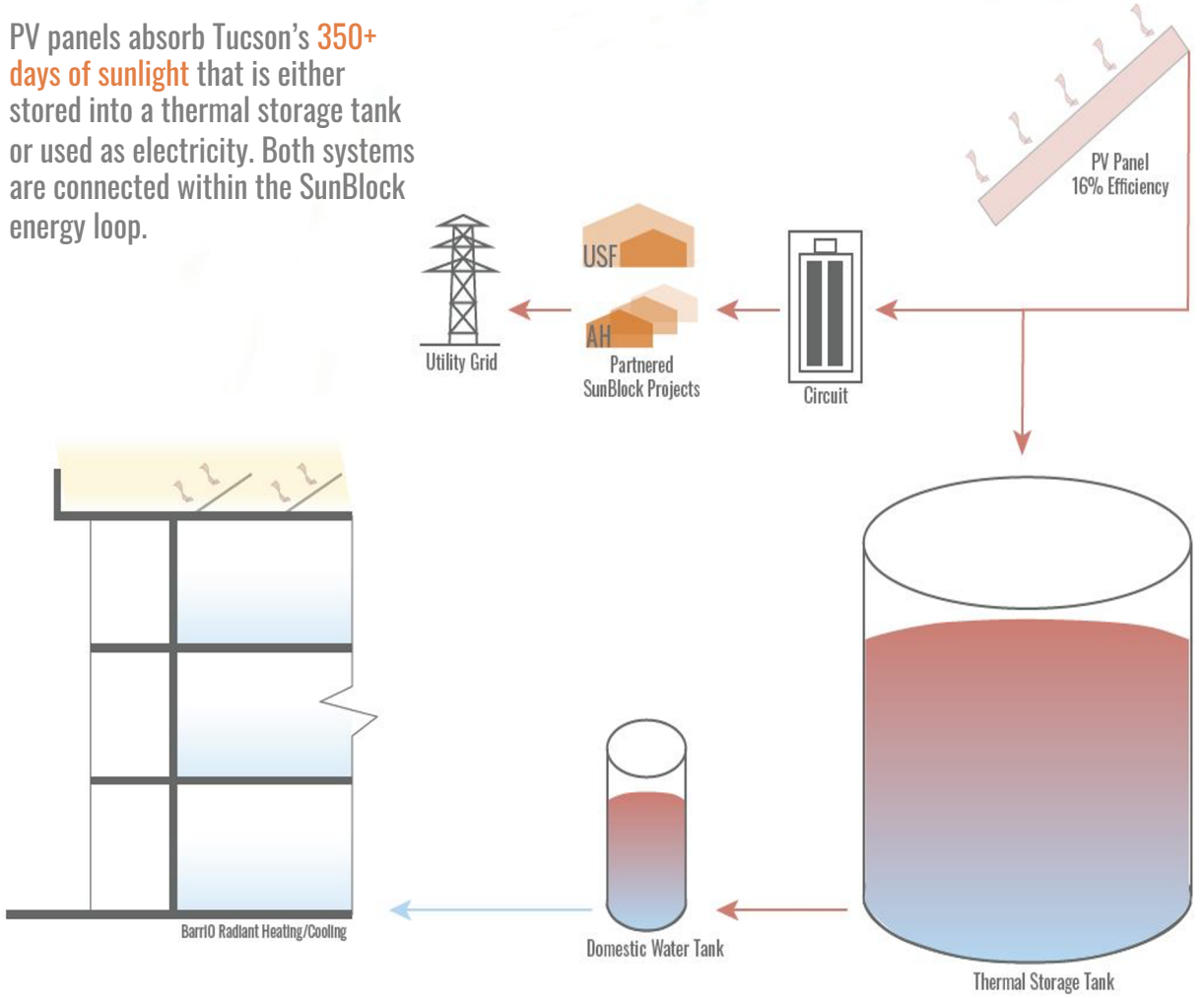
Passive Strategies

- Proper solar orientation
- Natural daylight
- Natural ventilation with solar chimney
- Roof overhangs with deep balconies with overhangs
- Brick screen wall shading device
- Airtight assembly
- Properly insulated based on climate zone



Renewable Systems

PV panels absorb Tucson's 350+ days of sunlight that is either stored into a thermal storage tank or used as electricity. Both systems are connected within the SunBlock energy loop.



Integrated Performance

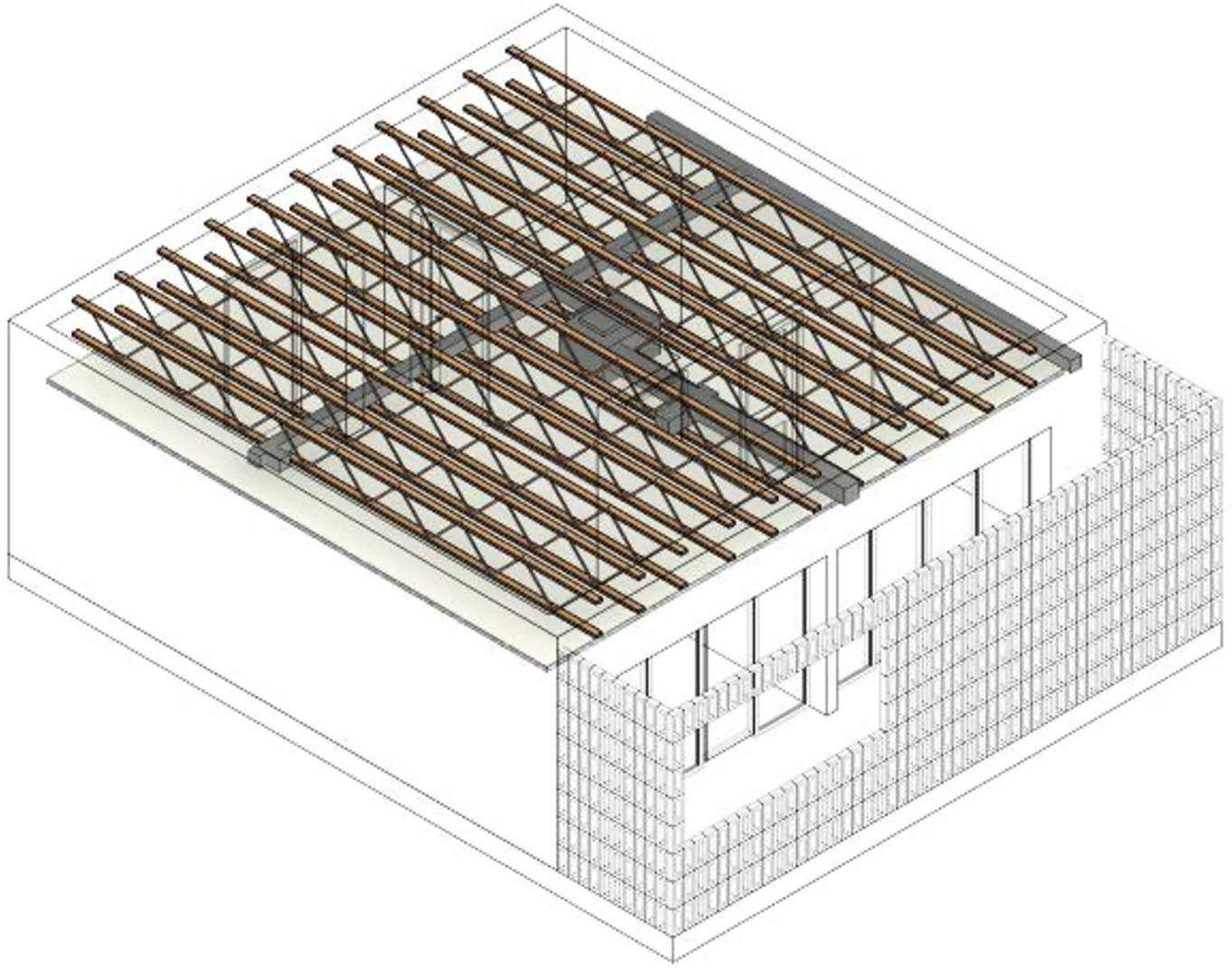
More details on pages 22-25 in Design Narrative

SUNBLOCK
Barrio Oeste

Subsystem Integration

The open web truss allows for subsystems to pass through its members for optimal integration. The integration of systems within the truss also allow for higher ceilings to have a greater opportunity for natural daylight and cross ventilation to flow throughout the unit.

The open webs that are not utilized with subsystems are insulated. Hidden ductwork through the dropped ceiling, insulated trusses, and incorporating silencers all help decrease noise levels both within the unit and from surrounding units.



Occupant Experience

More details on pages 26-28 in Design Narrative

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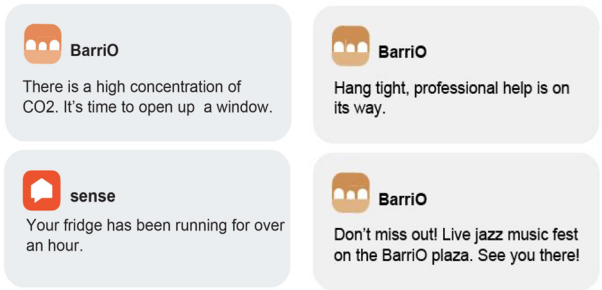
Barrio Oeste

BarriO App

Features:

- Maintenance request
- Community events
- Social network for new networks
- Tracks energy usage
- Public safety alerts
- Weather conditions
- Apartment's CO2 & humidity tracker
- Sunlink schedule
- Wellness center classes booking and schedule

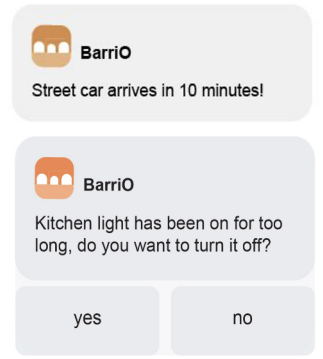


Energy Saving Sensors:

- SENSE Sensor: Understands how much energy the unit is using, when and where.
- Occupant Detection Sensor (Energy Control): Tracks what spaces are being inhabited and/or which spaces are not
- Carbon Dioxide Sensor (Honeywell): Helps control the rate of ventilation.

Neighborhood Activity and Ranking

The user with higher energy savings will win a free drink at the BarriO Cafe.



Comfort & Environmental Quality

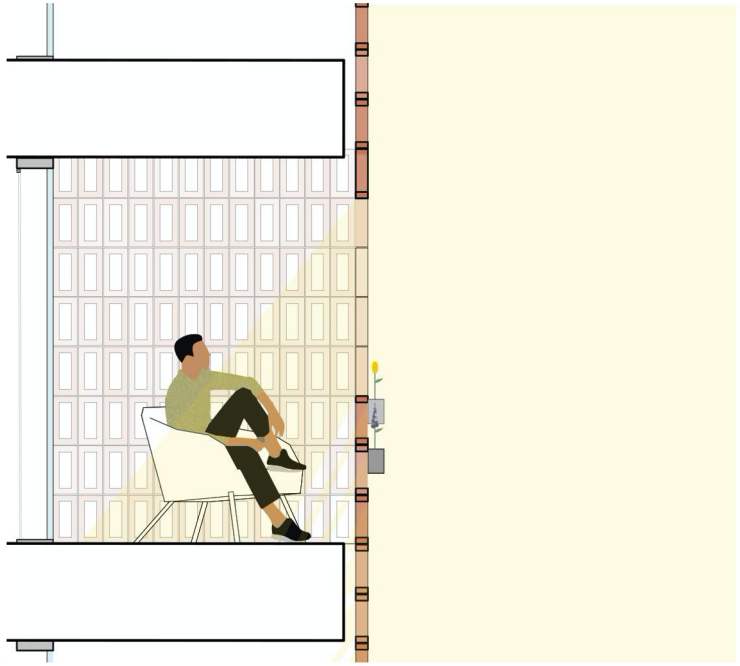
More details on pages 29-31 in Design Narrative

Interior Comfort Strategies

Aromatherapy + Biophilic Design:

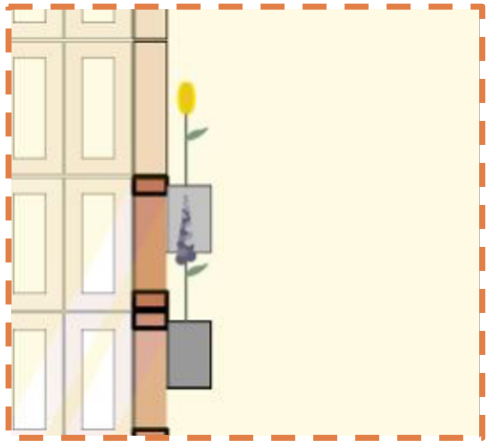
- Aromatherapy plants improve a person's wellbeing and help to destress.
- Biophilia design helps to improve the user's well-being, productivity, and creativity.

When the occupants can personalize their apartment, it makes them feel at home and boosts their wellbeing.



Natural Light in Design:

- Natural daylight improves mental health and physical health by increasing productivity.
- Well-lit environments help occupants feel safer, decrease levels of fatigue and increase comfort, efficiency, and accuracy.



Occupant X likes lavender, and added it to his planters:
Lavender:

- Helps reduce insomnia and depression.
- Helps in relaxation by improving coronary flow velocity.

Acoustical Design Strategy:

Cork and cellulose materials were used to prevent sounds to travel from one unit to another.
Reference page 31 Narrative.

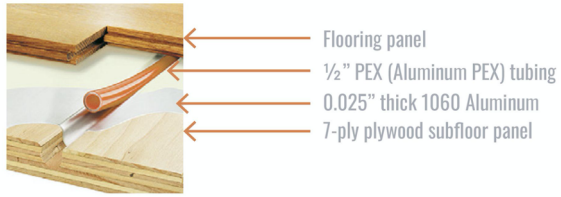
Comfort & Environmental Quality

More details on pages 29-31 in Design Narrative

SUNBLOCK
Barrio Oeste

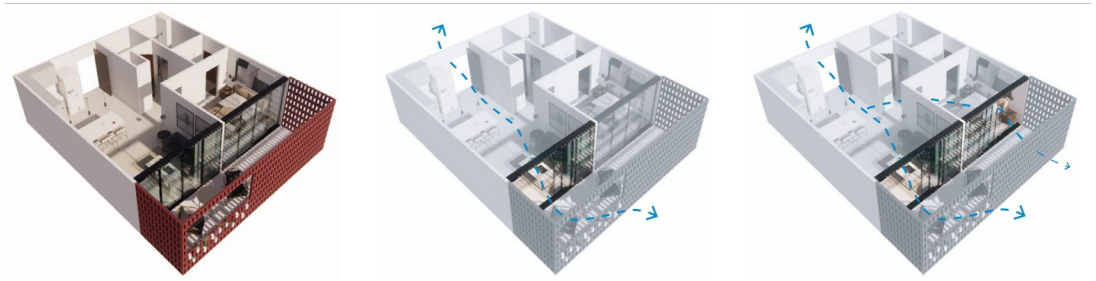
Radiant Floor

Warmboard is a structural subfloor and maximizes performance. High conductivity due to the aluminum sheathing brings the lowest water temperatures, and decreasing energy use



Natural Ventilation

Double-pane doors minimize unwanted solar radiation without compromising natural daylight, keeping the room cooler and reducing noise from outside.



Ultra-Aire Dehumidifier

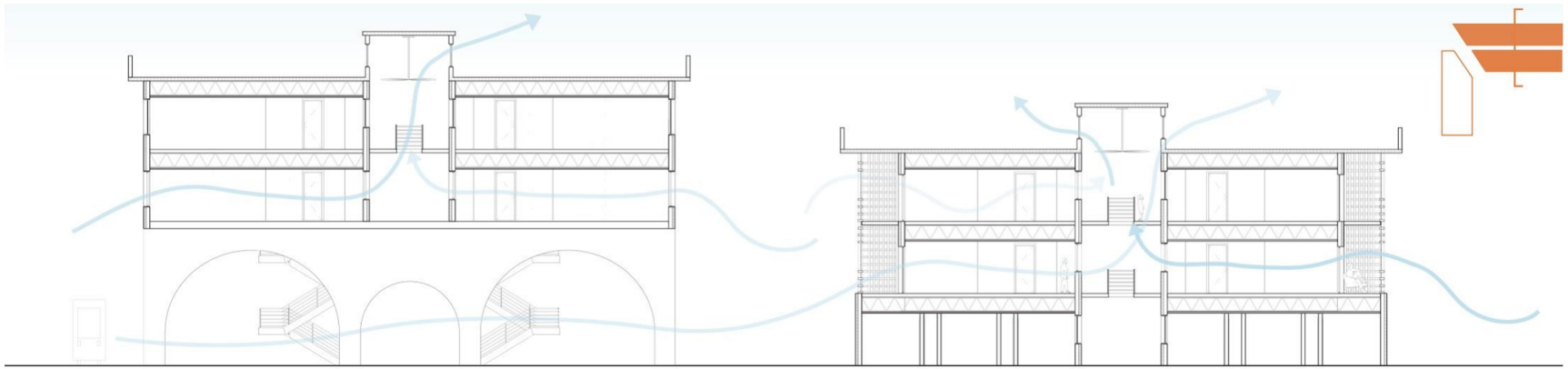
Controls the humidity and keeps the interior air above the dew point. Due to the use of radiant cooling, it is critical to keep the interior floors above the dew point temperature to avoid condensation.

Intelli-Balance Ventilation

Allows for compartmentalized individual units to improve indoor air quality and durability

Solar Chimney

A sensor will detect when will be a good time to open the louvers, and the BarriO app will let the residents know when is a good time to open up their windows to allow natural air to cool down the units through the solar chimney.



Thank you, from team BarriO!

SUNBLOCK
Barrio Oeste